

determined interval, and are disposed under the lower surface of the display part **110** in such a way as to be spaced apart therefrom.

[0159] That is, the vibrators are disposed on lower surfaces of the edges of the display part **110**, and are adjacent to the inner wall of the housing **120** but are spaced apart therefrom by a predetermined interval.

[0160] As such, the upper spacing portion **102** and the side spacing portion **101** prevent vibration from being undesirably transmitted from the vibrators to the display part **110** and the housing **120**, thus maximizing control efficiency of the vibration.

[0161] FIG. **20** is a detailed view showing a vibration isolating structure of the haptic display apparatus. A left-hand side view is a plan view of the haptic display apparatus, an upper right-hand side view is a front sectional view taken along line A-A', and a lower right-hand side view is a right side sectional view taken along line B-B'.

[0162] FIG. **20** illustrates the fourth vibrator **40**. As described above, the side spacing portion **101** is formed between a side of the fourth vibrator **40** and an inner surface of the housing **120**, and the upper spacing portion **102** is also formed between an upper surface of the fourth vibrator and the lower surface of the display part **110** to precisely transmit a vertical vibration force.

[0163] Such a spacing structure is advantageous in that transmission of vibration between the vibrator and the display part is performed only by the connection member connected to the central portion of the vibrator, thus considerably suppressing the undesirable transmission of vibration.

[0164] However, vibration may also be transmitted to a contact portion between the support portion formed in the housing and the vibrator. This vibration is transmitted to the housing and the display part, thus hindering vibration from being precisely controlled.

[0165] Thus, when viewed with reference to the fourth vibrator **40**, it is preferable that an isolating material **103** be further provided between a lower surface of an end of the fourth vibrator **40** and a portion facing the fourth support portion **124**.

[0166] The isolating material **103** may comprise an elastic material such as rubber, or comprise a material, such as silicone or adhesive, which is applied to absorb shocks by its own elastic force while performing direct bonding. Preferably, the isolating material **103** takes a shape of a double-sided adhesive film.

[0167] FIG. **21** is a perspective view showing the haptic display apparatus having the vibration isolating structure.

[0168] As described above, the side spacing portion **101** is formed between the side of each vibrator **10**, **20**, **30** or **40** and the inner wall of the housing **120**, and the upper spacing portion **102** is formed between the upper surface of the vibrator and the lower surface of the display part **110**, thus preventing undesirable vibration from being directly transmitted from the vibrators to the housing and the display part. Thus, the transmission of the vibration to the display part can be performed only by the connection members **41**, **42**, **43** and **44**.

[0169] Further, the lower surfaces of both ends of the vibrator are supported on the upper surfaces of the support portions **121**, **122**, **123** and **124**, and the isolating material **103** is interposed between the lower surfaces of both ends of the vibrator and the upper surface of the corresponding support portion, thus isolating vibration.

[0170] According to the preferred embodiment of the present invention, both ends of the PZT beam vibrator are supported by the support portion. However, one-end support type of vibrator may be used. In this case, one end of the vibrator may be supported by the support portion of the housing, while the other end may be connected through the connection member to the lower surface of the display part.

[0171] Further, an example wherein the lower surfaces of both ends of the vibrator are in contact with or bonded to the upper surface of the support portion has been described. However, a predetermined groove may be formed in the support portion to support the upper and lower surfaces of the vibrator. In this case, the isolating material may be uniformly applied to a contact surface.

[0172] Meanwhile, as described above, according to the concept of adjusting the vibrating position of the display part through a plurality of vibrating points while having the vibration isolating structure, it is preferable that the vibrators have output of the same frequency and amplitude. Therefore, the vibrators comprise vibration beams having the same mechanical performance and the same length.

[0173] Here, if the display part **110** has a rectangular shape, a vertical length thereof is larger than a lateral length thereof. The arrangement of the first and third vibrators **10** and **30** using the support portions is different from that of the second and fourth vibrators **20** and **40** using the support portions, which will be described below.

[0174] FIG. **22** is a perspective view showing the housing of the haptic display apparatus according to the present invention.

[0175] As described above, the housing **120** supports the display part **110** at an upper position, and supports the vibrators **10**, **20**, **30** and **40** therein. The housing **120** is provided with the support portion as the vibrator support structure.

[0176] Each support portion having a predetermined lateral length and a predetermined vertical length is formed on the corner of the inner wall of the housing **120**. The upper surface of the support portion is spaced apart from the lower surface of the display part by a predetermined interval.

[0177] As shown in FIG. **22**, when the display part and the housing take a rectangular shape that is long in vertical length and the vibrators have the same shape, the support portions are different from each other in lateral and vertical lengths. That is, each support portion is long in vertical length and is short in lateral length.

[0178] The vertical length and lateral length of each support portion depend on length of the vibrator beam. Thus, the spacing distance between the first and second support portions **121** and **122** is equal to the spacing distance between the first and fourth support portions **121** and **124**. Similarly, the distance between the second and third support portions **122** and **123** and the distance between the third and fourth support portions **123** and **124** depend on the length of the vibrator beam, more precisely, the length of the beam vibrating vertically in the spacing space between the support portions.

[0179] Meanwhile, the portions for supporting the first and third vibrators **10** and **30**, namely, the vibrators arranged in the lateral direction may be stepped to be recessed towards the inner wall of the housing, in consideration of the spatial arrangement.

[0180] As described above, when the vibrating point is formed on each edge of the display part to be vibrated by the PZT beam vibrator and the excitation frequency is adjusted within the domain less than the primary resonant frequency,